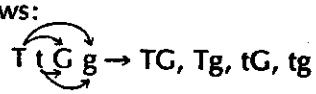
Name _____ Date _____

HEREDITY AND DEVELOPMENT 10

Crosses Involving Two Traits

Predicting the outcome of crosses involving two traits requires basically the same procedure as that for crosses involving one trait. Keep in mind that in these crosses the genes controlling the two different traits are located on nonhomologous chromosomes. During meiosis nonhomologous chromosomes assort randomly, or independently. This means that each of the chromosomes of any pair of homologous chromosomes has an equal probability of ending up in a gamete with either chromosome from any other pair of homologous chromosomes. For example, assume that chromosomes A′ and A″ are one pair of homologous chromosomes and chromosomes B′ and B″ are another pair of homologous chromosomes. Therefore, A and B chromosomes are nonhomologous with respect to each other. During meiosis there is equal probability that chromosome A′ will assort with chromosome B′ or B″. Likewise chromosome A″ is equally likely to assort with chromosome B′ or B″. This results in equal numbers of gametes with the nonhomologous chromosome combinations A′B′, A′B″, A″B′, and A″B″. Obviously then, genes that occur on nonhomologous chromosomes will also assort independently with respect to each other during meiosis.

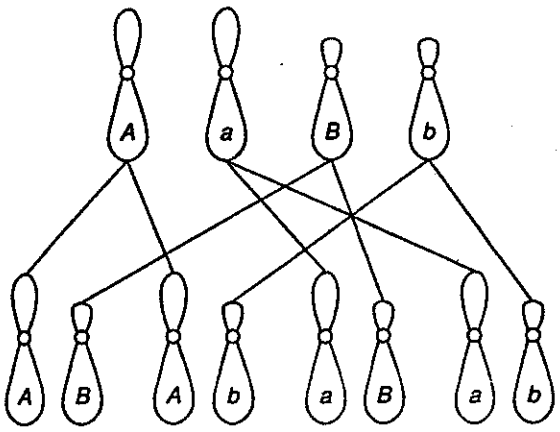
To illustrate this situation, consider a plant that is heterozygous tall (Tt) and heterozygous green (Gg). This plant has the genotype TtGg. The T and t alleles (for height) are located on one pair of homologous chromosomes while the G and g alleles (for color) occur on another pair of homologous chromosomes. Since the genes for these traits are on nonhomologous chromosomes, during meiosis they will assort independently. This means that each allele for height, T and t, has an equal probability of assorting in the same gamete with either allele for color, G or g. To determine the possible gamete genotypes that this plant will produce, you must combine each height allele with each color allele. This can be done as follows:



Thus this plant will produce equal numbers of gametes with the genotypes TG, Tg, tG, and tg.

TWO FACTOR CROSSES

Crosses that involve two traits, such as pod color and pod shape, are called two-factor crosses. Predicting the outcome of two-factor crosses requires basically the same procedure as that for crosses involving one trait. Keep in mind that in two-factor crosses the genes controlling the two different traits are located on nonhomologous chromosomes. During meiosis, nonhomologous chromosomes assort independently. This means that each of the chromosomes of any pair of homologous chromosomes has an equal probability of ending up in a gamete with either chromosome from any other pair of homologous chromosomes. The genes that are located on nonhomologous chromosomes also assort independently, as you can see in the following diagram.



Because of independent assortment, a plant that is heterozygous for two traits (genotype *AaBb*) will produce equal numbers of four types of gametes—*AB*, *Ab*, *aB*, and *ab*.

In the example that follows, we will predict the results of a cross between two plants that are heterozygous for both pod color and pod shape.

Practice Problems

In mice, the ability to run normally is a dominant trait. Mice with this trait are called running mice (*R*). The recessive trait causes mice to run in circles only. Mice with this trait are called waltzing mice (*r*). Hair color is also inherited in mice. Black hair (*B*) is dominant over brown hair (*b*). For each of the following problems, draw a Punnett square in the space provided and fill in the information on the indicated lines.

1. Cross a heterozygous running, heterozygous black mouse with a homozygous running, homozygous black mouse.

   Parental genotypes: _____

   Phenotypic ratio: _____

2. Cross a homozygous running, homozygous black mouse with a heterozygous running, brown mouse.

   Parental genotypes: _____

   Phenotypic ratio: _____

3. Cross a waltzing brown mouse with a waltzing brown mouse.

   Parental genotypes: _____

   Phenotypic ratio: _____

4. Cross a homozygous running, heterozygous black mouse with a waltzing brown mouse.

Parental genotypes: _____

Phenotypic ratio: _____

5. Cross a heterozygous running, brown mouse with a heterozygous running, homozygous black mouse.

Parental genotypes: _____

Phenotypic ratio: _____

For each exercise, (a) show the parental genotypes, (b) use fractions and (c) answer the question, in the spaces provided.

In mice, the ability to run normally is a dominant trait. Mice with this trait are called running mice (R), The recessive trait causes mice to run in circles only. Mice with this trait are called waltzing mice (r). Hair color is also inherited in mice. Black hair (B) is dominant over brown hair (b).

1. Cross a heterozygous running, heterozygous black mouse with a homozygous running, homozygous black mouse. What is the probable phenotype ratio?

   a. _____ b. c. _____

2. Cross a homozygous running, homozygous black mouse with a heterozygous running, brown mouse. What is the probable phenotype ratio?

   a. _____ b. c. _____

3. Cross a waltzing brown mouse with a waltzing brown mouse. What is the probable phenotype ratio?

   a. _____ b. c. _____

4. Cross a homozygous running, heterozygous black mouse with a waltzing brown mouse. What is the probable phenotype ratio?

   a. _____ b. c. _____

5. Cross a heterozygous running, brown mouse with a heterozygous running, homozygous black mouse. What is the probable phenotype ratio?

   a. _____ b. c. _____

Name _____ Class _____ Date _____

B. The product rule is a useful principle of probability. It states that the probability of independent events occurring at the same time is the product of each of their probabilities. For example, if you flip a penny and a nickle at the same time, the probability of both coins coming up heads is 1/2 × 1/2, or 1/4. (The probability for a single flipped coin to come up heads is 1/2.) If you were to flip a penny, a nickle, and a dime at the same time, the probability of all three coins coming up heads is 1/2 × 1/2 × 1/2, or 1/8.

Use probability and the product rule to solve the following problems.

1. In sweet-pea plants, purple flowers (*P*) are dominant over red flowers (*p*) and short seeds (*L*) are dominant over long seeds (*l*). A sweet-pea plant that is heterozygous for flower color and seed length is crossed with a plant with red flowers and long seeds.

   a. Write this cross. _____

   b. What fraction of the offspring from this cross will have genotype *PpII*? _____

2. Two individuals with the genotype *AaBbDd* are crossed.

   a. What fraction of the resulting offspring will have genotype *aabbdd*? _____

   b. What fraction will have genotype *AaBbDd*? _____

   c. What fraction will have genotype *AABBDd*? _____

3. A plant with genotype *DdEeFfGgHh* reproduces by self-pollination.

   a. What fraction of its offspring will have genotype *DDEeffGGHh*? _____

   b. What fraction of its offspring will have genotype *DdEeFfGgHh*? _____

   c. What fraction of its offspring will have genotype *ddeeffgghh*? _____

   d. What fraction of its offspring will have genotype *ddEEffGGhh*? _____